Special Issue on the Nuclear Testing Crisis

Full Text SANE's Comment on Eisenhower's Action, P. 2; Some Geneva Documents on Muffling, P. 3

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Dr. Teller's Latest Nuclear Nightmare

The Father of the H-bomb seems determined to spawn more nightmares. In his campaign to continue nuclear testing, he's back with a new one, a hole-in-the-earth theory for secret testing which mankind needs (as Harry Golden would say) like a hole in the head. The theory was first presented in a Rand report last March 30 (*A Method of Concealing Underground Nuclear Explosions,* R-348) with a note saying the work "was undertaken at the suggestion of Dr. Edward Teller." According to a Rand Corp. release Dec. 21, the day the theory was unveiled at a State Department press conference, this study was declassified Oct. 20, 1959 "to permit its use at the Geneva talks . . . subject to a public release date later, dependent upon the progress of the talks." The State Department complained that Soviet scientists at Geneva had rejected this theory that the size of the tell-tale seismic signal from an underground blast could be reduced 300-fold. A week later some of the scientists who worked on it made a joint presentation at an American Physical Society meeting at Pasadena. A prepared summary was made available the same day in Washington by the AEC. The impression created was that this new method for muffling nuclear explosions could (as the *New York Times* reported Dec. 30) "make the international test-detection program virtually useless."

Could You Hide All That Digging?

The Russians at first rejected but finally accepted the theory (as the reader can see for himself on page three). The problem on which the British as well as the Russians have doubts, is whether it can be successfully applied in practice on any significant scale. A mere important question, not touched on at Geneva, arises in the sphere of intelligence: even if you could hide the nuclear explosion, could you hide the work of building the hole? There seems to be general agreement here that the easiest kind of movement for intelligence to spot are large-scale digging operations. Even for a 100-kiloton shot the job of digging the hole would be enormous. A scientist friend kindly translated the formula given by the U. S. delegation into tonnages for us. A cavity large enough for a 100-kiloton shot in hard rock would require the movement of 25,000,000 tons of rock or about 5,000,000 truck loads. For a cavity in salt, the tonnage would be somewhat smaller, closer to 20,000,000 tons. Some figures we obtained from the Bureau of Mines show the magnitude of these operations. Total rock salt mined in this country in 1958 was 5,407,000 tons. Teller's "big hole" in salt would require the movement of four times that much. Total production of anthracite coal last year, on which 21,000 men were employed, was 19,500,000 tons. To take from one hole more tonnage of rock than is taken in one year from all the anthracite mines of Pennsylvania would be a formidable and terribly expensive task, taking several years, if feasible.

Constructive Proposals Pigeon-Holed

Perhaps this is why the Berkner panel, assigned by the White House last year to study all the new data, treated this deep hole muffling theory with such equanimity (see excerpt on page 3), although several of those who worked on the Rand report also served with the Berkner panel. Five days after the Berkner panel report was made available in summary form last year, the President (June 17) was asked by the *Time* magazine correspondent about these new muffling techniques. Mr. Eisenhower's answer brushed them aside. The Berkner panel in its report to him had concluded that with the development of fresh ideas available in the field of seismic detection, the Geneva control system agreed upon in 1958 could be restored to full effectiveness within three years. Unfortunately its recommendations for research and development have been pigeon-holed while Pentagon and AEC pour their energies into every idea like Teller's hole-in-the-earth which promises to upset the possibilities of agreement. As recently as November 17, in a letter to Senator Humphrey, the President said that while any disarmament agreement carried "some risks, at least theoretically, of evasion" these must be balanced against "the enormous risks entailed if reasonable steps are not taken to curb the international competition in armaments." The President would hardly have spoken so confidently if he thought the Teller muffling theory represented a practical technique which "made the international test-detection program virtually useless." Indeed the President made no reference to this muffling theory in the statement he issued at Augusta, Ga., Dec. 29 angrily announcing that the U. S. considered itself free to resume tests at any time but would give notice if it did so.

How Federov Helped McCone

The tone of this statement reflects the use made by AEC Chairman McCone of the bitter language by Mr. Federov in his final report for the Soviet delegation. This cast doubt on "the quality and objectivity of the figures that were supplied by the Americans" and attacked the U. S. delegation for "tendentious use of one-sidedly developed material for the purpose of undermining confidence in the control system" agreed upon at Geneva in 1958. This broadside attack, which reflected on members of the U. S. delegation like Dr. Fisk and Dr. Bethe, who are not in the Teller camp, played into the hands of those who want to resume testing.

The participants in that 75 minute conference at the

(*Continued on Page Four*)

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Scientists Say Even Small Underground Tests Still Very Difficult to Hide

One Veto-Free Inspection Every Two Weeks Called Ample for Policing

By The National Committee for A Sane Nuclear Policy

We reprint here the full text of the statement by the National Committee for A Sane Nuclear Policy on the crisis in the Geneva test negotiations. Though generally ignored by the press, it is the best we have seen on the tangled technical issues. The statement was prepared by the Committee's Science Advisory Group of which the co-chairmen are Dr. Seymour Melman, Industrial Engineering Department, Columbia University, and Dr. Hugh C. Wolfe, Dept. of Physics, Cooper Union.

With the announcement by President Eisenhower that the United States will refrain from nuclear weapons tests for the present, but not continue its formal moratorium, the efforts to secure a workable and inspected treaty on ending tests enter a crucial phase. The wording of the American announcement was intended to speed up the Geneva talks and increase pressure on the Russians. Unfortunately an opposite effect is equally possible. The stated position of the British, that they would not interrupt the moratorium as long as the talks continue, is a more useful one.

If further progress is to be registered, the following principles must be kept in mind:

Every inspection system for disarmament undermines internal security systems.

On the Soviet side, there is surely substantial fearfulness of the internal security effects. This factor probably plays a lesser, but still important role on the American side.

Every inspection system has limits of accuracy.

Some of the limits on instrumental observation can be cushioned by on-the-spot inspection of events of doubtful meaning. Such inspection, however, clearly invokes the internal security effects noted above, and is therefore underrated by the Soviet Union.

Some Basic Questions

The limits of accuracy of seismic and observation systems that are implied in the published reports on the Nevada and allied tests in the United States must be evaluated in terms of the following questions:

(A) What is the military significance of the explosion sizes that are clearly beyond the reliable observation capability of a system?

If this military significance is not overriding, there are strong grounds for embarking on an agreement. Two facts are particularly relevant:

1. The apparent availability of sufficient nuclear explosives for "overkill."

2. The fact that the military establishment is now mainly interested in improving big bombs for missiles. Explosions of these megaton-range devices cannot be hidden in the foreseeable future.

(B) Is refinement for greater precision in detection systems a reasonable expectation in light of the present state of the technical arts involved?

The answer to this question must be an unqualified "yes". The Russian willingness to consider means of improving detection, manifest in the recent scientific meeting, is important in this respect. Provision for research and development and for revision of inspection systems must be written into all arms control agreements. The Draft Treaty being considered has such provisions.

Much Effort on Evasion, Too Little on Detection

If indeed the agencies concerned had expended a comparable amount of effort and funds on improving methods of detection as they have in evolving modes of evasion, the task before us would be much less confused.

Two kinds of demand have the effect of frustrating international arms control agreement.

(a) A demand for inspection without social effects within the countries being inspected.

(b) A demand for flawless reliability.

In the recent scientific meeting on detection of underground explosions, the Soviet Union and the United States were unreasonable with regard to the first and second of these points respectively:

The Soviet Union proposed that seismic signals so large that they were meaningless, be used to set the criteria for on-site inspection. They were in addition unreasonable in not considering data from American tests, and in not examining the possibility of muffling explosions in excavated cavities.* The United States, on the other hand, suggested signals so low as to be confused with background noise used to establish the inspection criteria. Under this concept every disturbance would be eligible for on-site inspection, requiring unrealistic numbers of sorties [for on-site inspection].

Basically, however, the question is a political one, and not a scientific one, in which the risks of any agreement must be weighed against the risks of having none.

The possibility of muffling kiloton-range underground explosions and the problem of detecting very small explosions must now be accepted as part of the "calculated risk." It should be emphasized, however, that a combination of on-site inspection and available instrumentation will render it extraordinarily difficult to hide such tests.

The Truth About Teller's "Big Hole"

It should also be noted that there is a wide discrepancy between what is theoretically possible and what is technically realistic. With regard to excavations to muffle explosions, no one has ever dug a hole as large as those suggested to muffle a 100-KT explosion. If it should prove possible, the expense would exceed that of the nuclear device by hundreds of times, the excavation would require several years, and be difficult to hide. The same is true regarding explosions in "outer space."

Thirty on-site inspections per year in Russia, and a similar number in the United States, together with instrumentation now possible, provide sound initial measures for an inspection system. The quota of 30 inspections will involve random sampling of large and small signals, at the rate of about one every two weeks.

A first agreement of this sort will—

(a) Establish the principle of mutual inspection.

(b) Result in installation of a degree of actual inspection from which lessons can be learned and precedents set.

(c) Provide the world a "breathing spell" from the multiplication of nuclear powers and the drift toward nuclear war.

A first agreement can be followed up with more stringent measures.

A treaty ending all nuclear tests under adequate controls remains a technically feasible possibility. The United States should not relent in its efforts to secure such a treaty.

***Our own reading of the final reports and the transcript of the technical sessions of Geneva do not support this statement. The Soviet scientists disagreed with ours on the Hardtack tests and the muffling idea but certainly discussed both at great length. As for the criteria—the Russians on Dec. 3 put forward a set of criteria which were not only appallingly restrictive but would give rise to prolonged wrangles over interpretation. These were dropped in their final report.**

—IFS

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A Page for Scientist Readers Who Want More Facts on Teller's Newest Nightmare

The Basic Geneva Documents on The "Big Hole" Theory for Hiding Tests

Because many scientists are subscribers to the Weekly, because the basic documents on the nuclear crisis in Geneva are so hard to obtain, and because of the interest in the Teller theory of hiding tests in cavities, we reprint here the full text of those portions of the final reports turned in by the scientists in Geneva, which state their different views on this possibility. We also give that section of the Berkner report which discusses the "big hole" theory though in veiled terms because it was still classified at that time. We would like to hear from scientist readers in order more fully to understand these technicalities which have created a new obstacle to agreement. We ask non-scientist readers to excuse the devotion of so much space to highly technical matters but believe it justified in the interests of peace.

—IFS

What the U.S. Delegation Said:

"Rigorous theoretical calculations combined with measurements on the Rainier explosion show that the seismic signal produced by an explosion in a sufficiently large underground cavity in salt or hard rock will be reduced by a factor of 300 or more relative to the seismic signal from an explosion of the same yield under Rainier conditions. Calculations indicate that a cavity at a depth of about one kilometer with a volume of 7 x 10^4 cubic meters per kiloton should suffice.

"Cavities are known to exist in salt formations which would satisfy the volume requirement for explosions at least as large as 70 kilotons. The total construction time for a cavity of this size in a salt dome is estimated to be from 2 to 4 years."

What the British Delegation Said:

"Theory shows that the seismic signal generated by a nuclear explosion in an underground cavity can be much less than that from an equal explosion in RAINIER conditions. The theory assumes that the cavity is sufficiently large and deep for the material around the cavity, right up to the boundary surface, to behave elastically. Calculations indicate, for example, that a cavity in salt, one kilometer below ground level, of volume 7 x 10^4 m^3 per kilton, should suffice to meet the theoretical requirements.

"The theory assumes a perfect isotropic medium, and makes certain assumptions about the stress distribution around the cavity before the explosion occurs. Careful work would have to be done before it could be stated that conditions likely to be met in practice do not require the theory to be modified. However, it may well be possible in practice, should the necessary scientific research and engineering effort be found, to give confidence that a decoupling factor of two orders of magnitude compared with RAINIER conditions could be achieved.

"Experiments have been made to compare the seismic signals at about one mile from high explosive charges, exploded in an underground cavity, with those given by smaller charges placed a few feet from the cavity in the surrounding limestone. Apparently ten times as much explosive was required in the cavity as in the surrounding limestone to give equal seismic signals. A decoupling factor of about one order of magnitude in limestone has thus been demonstrated for one cavity which was smaller and less deep than those demanded by the above-mentioned theory.

"Cavities are known to exist in salt formations which would satisfy the volume and depth requirements for a few kilotons. The cavities are not spherical shape and the stress distributions around the cavities are not known."

Big Enough for A Dozen RCA Buildings

"However, to apply cushioning to a 100 kiloton bomb would require an underground cavity 800 feet in diameter (large enough to hold a dozen RCA buildings). Such grandiose man-made chamber would be very expensive and might take several years to build, according to Dr. Harold Brown, associate director of Livermore Laboratory."

—Prof. Jay Orear (Physics, Cornell), chairman of the disarmament committee, Federation of American Scientists, letter to New York Times, Jan. 6.

Skeptical British View

"British experts accept the theoretical argument of the 'large hole' and most of the American arguments derived from the Nevada underground explosion. But the British believe that much more experiment is needed before firm conclusions can be drown. They also doubt whether the 'large hole' could be made to work in practice as a way of concealing significant nuclear-weapon development."

—Robert Stephens, diplomatic correspondent, London Observer, Jan. 3.

The Soviet Delegation Said:

"During discussion of the amplitude of the seismic signal produced by an underground nuclear explosion, the U. S. delegation introduced the idea that the seismic signal could be disguised by carrying out the explosion in a sufficiently deep and large underground cavity. The U. S. experts' views on the possibility of considerably reducing the seismic signal under such conditions are, in the main, based on general considerations of theory. However, even from the theoretical point of view, the earth's crust is a very complex medium. Therefore, a combination of formal mathematical solutions for the problems involved in the dissimulation of underground explosions does not as yet offer a sound basis for any findings relating to the possible amplitude of the seismic signal generated by an explosion in a deep underground cavity or to the technical feasibility of carrying out vast underground construction operations at a depth of the order of one kilometre."

What the Berkner Report Said:

"In considering the possibility that the capabilities, now or in the future, of the Geneva System might be reduced by the intentional concealment of underground tests, the Panel concluded that decoupling techniques existed which would reduce the seismic signal by a factor of ten or more. Moreover, preliminary theoretical studies have shown that it is possible in principle to reduce the seismic signal from an explosion by a much greater factor than this. Nevertheless, in view of the many complexities involved, it is necessary that these ideas be tested with appropriately designed experiments to determine how large a decoupling factor can actually be realized in practice. While many of these tests can be carried out with high explosives, complete evaluation of the theory probably cannot be made without nuclear explosions. *Such tests may also disclose some characteristics which might allow long range detection of such decoupled underground tests.*" (Italics added—IFS.)

—Report of the Berkner Panel appointed by the President to review the feasibility of improving the detection system agreed upon in Geneva in 1958; from the summary made public June 12; two of those who worked on the Teller "big hole" theory, Prof. David T. Griggs and Dr. Albert Latter, also worked with the Berkner panel.

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Anderson Statement Shows Advocates of Resumption Want Atmospheric Tests

(*Continued from Page One*)

Augusta National Golf Club took advantage of Mr. Eisenhower's temper. The statement he was persuaded to issue gave the impression that the Soviet scientists had failed to give "serious scientific consideration" to the new data presented by the U. S. delegation and had utilized "technically unsupportable" arguments. We do not think the verbation transcript available at the State Department bears this out. This may explain the failure to produce that statement the President promised in which the U. S. delegation would "make public from the verbatim records of the conference the facts which will completely refute the Soviet document." * The verbatim shows the Russians not only discussed the new data at length but revised some of their own opinions, as did the U. S. delegation. Russian objections, far from being "technically unsupportable," were buttressed by seismological data and mathematical demonstrations of their own.

A Pot and Kettle Argument

The President accused the Soviet scientists of being "politically directed" but this was true of both sides. The final report from the Soviet side accused the U. S. delegation of "even some misrepresentation" in presenting material which all tended "in one single direction—towards reducing the estimates of the control system's effectiveness." The U. S. delegation might have answered that all the Soviet statements similarly tended in the direction of overestimating the control system's effectiveness. Their delegation was operating in the framework of a national policy which seeks to cut down the number of on-site inspections in fear of espionage. Ours was operating in the framework of a national policy which seeks to maximize the number of inspections in fear that the Russians may carry on tests in secret.

The truth, as Sir Michael Wright summed it up very ably for the British delegation just before adjournment on Dec. 19 is that seismology is still a very young and inexact science. More study and development is called for and there will be less wrangling if this could be done jointly—as Sir Michael suggested—so that both sides would be satisfied with the conditions observed and with the results obtained.

Everything we read in the verbatim convinced us of the wisdom of the proposal put forward by Senator Humphrey in his Oct. 30 speech at Pontiac, Michigan, where he proposed an agreement to bar all tests above 5 kilotons and then make a joint study of how to detect those below 5 kilotons during a two year moratorium on the smaller shots. It is, after all, only in this low range that the difficulties of detection arise.

Ill-Advised and Petulant

The President's decision not to extend our own moratorium beyond Dec. 31 seems to us hasty and ill-advised. He had just returned from a world tour as a leader for peace. The nuclear test announcement sent a tremor of anxiety through the hearts of millions the world over who had placed their trust in him. If nuclear tests resume, the arms race and world tension are likely to spiral upward again. Our action was taken in the face of a resolution passed only a few weeks earlier, 76-to-0, by the United Nations General Assembly. This resolution, by Austria, Japan and Sweden, called on the nuclear powers "to continue their present voluntary discontinuance of the testing of nuclear weapons." The U. S. itself voted for the resolution. Finally Mr. Eisenhower's action must be seen against the background of the Paris meeting with our NATO allies which was intended to demonstrate our readiness to confer with them on all matters of mutual concern. Yet the President acted on so momentous a matter without consulting our European allies (*Washington Post,* Dec. 31) or even our British partner in the nuclear talks (*Baltimore Sun,* London Bureau, Dec. 30). On a matter which so deeply concerns all mankind, we acted in a way which gives the appearance of swift and arbitrary petulance. Even if the President intended only to put bargaining pressure on the Russians, the result will be to build up more pressure on him at home for resumption of tests, and as Senator Anderson indicated the advocates of testing will not be satisfied to keep them underground.

*Although Mr. Hagerty promised such a refutation "within a few days" (Baltimore Sun, from Augusta, Ga., Dec. 30), State Dept. says it knows of no plans to issue anything further than its release of Dec. 29 giving Dr. Fisk's reply to the Russians at Geneva on Dec. 19.

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IFS To Speak Community Church, Boston, Sunday Morning, Jan. 17 on Nuclear Testing Crisis

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